Lyα absorbers arising in galaxy clusters

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Abstract. We present here new GHRS observations of Lyα absorption lines associated with groups or clusters toward the QSOs 1545+2101 and 0850+4400. In the first case we have identified at least eight distinct Lyα absorption features, with a mean redshift of $< z >= 0.2648 \pm 0.0002$ and a velocity dispersion of 163 ± 57 km s^{-1}. We have also identified a group or cluster of galaxies in the vicinity of this QSO with a mean redshift of $< z >= 0.2643 \pm 0.0004$ and velocity dispersion 223 ± 91 km s^{-1}. The spectrum of QSO 0850+4400, of poorer quality, reveals two Lyα absorption features at $z = 0.0909500 \pm 0.0000070$ (which is just resolved) and $z = 0.0948215 \pm 0.0000090$, separated by ~ 1060 km s^{-1}. A group or cluster of galaxies is also present in the vicinity of the QSO line-of-sight with a mean redshift $< z >= 0.0901 \pm 0.0007$ and velocity dispersion of 530 ± 200 km s^{-1}. The results of this work establish that Lyα absorption can occur in denser than average galaxy environments, and that it arises in discrete objects spanning a velocity range similar to that of the cluster galaxies. Although a one-to-one relationship between absorbers and galaxies is difficult to establish in such a dense environment, the results obtained here are indeed consistent with the Lyα absorption lines being associated with individual galaxies also in groups and clusters. Moreover, the data shows clearly that line clustering takes place in the Lyα forest.

1 Absorption systems & groups of galaxies

Details about the GHRS spectra of 1545+2101 and 0850+4400 (see Fig. 1) will be presented elsewhere [3]. A standard Voigt profile fitting [1] to individual lines (or groups of them) shows the following features in each field: (a) 1545+2101: two lines are found at $z = 0.2504707 \pm 0.0000030$ and $z = 0.2522505 \pm 0.0000016$, with a velocity separation of ~ 427 km s^{-1}. Also present is a group of eight lines, whose redshift centroid is $< z >= 0.2648 \pm 0.0002$ with a velocity dispersion of 163 ± 57 km s^{-1}. (b) 0850+4400: two lines are detected at $z = 0.0909500 \pm 0.0000070$ and $z = 0.0948215 \pm 0.0000090$, with a velocity separation of 1062 ± 3 km s^{-1}.

A number of galaxies in these two fields have been observed spectroscopically [2] to determine their possible connection to the absorption features detected on the QSOs spectra: (a) 1545+2101: a galaxy is found at $z = 0.2510$, its impact parameter value being $\rho = 306.4\ h^{-1}$ kpc. Moreover, there is a group or cluster of six galaxies with redshift centroid $< z >= 0.2643 \pm 0.0004$ and velocity dispersion of 223 ± 91 km s^{-1}, whose impact parameters range from 47.6 to $456.4 h^{-1}$ kpc. (b) 0850+4400: there is a group or cluster of seven galaxies with redshift centroid $< z >= 0.0901 \pm 0.0007$ and velocity dispersion of 530 ± 200 km s^{-1}. Impact parameter range is 38.5 – 117.8 h^{-1} kpc

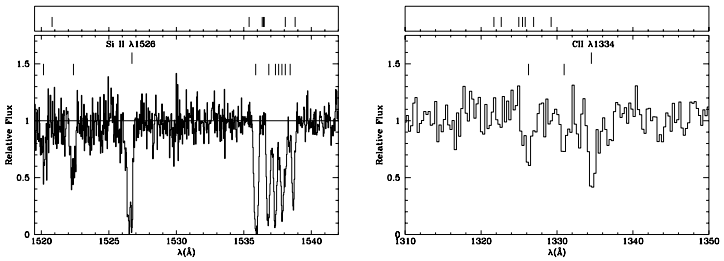

Figure 1: Spectrum of 1545+2101 (left) and enlarged extract from spectrum of 0850+4400 (right). Tick marks in the upper pannel indicate the predicted wavelengths of Lyα at the redshifts of the galaxies. Tick marks in the lower pannel show the positions of the detected absorption lines

($h = H_0/(100\ \ \mathrm{km\ s^{-1}Mpc^{-1}})$, $q_0 = 0.5$).

The fact that we observe a number of resolved lines shows that the absorptions arise in discrete clouds of cold gas instead of arising in a large single diffuse gas component. The comparison between the cross-correlation function (CF) between the galaxies and absorbers in the data with the CF corresponding to a random case shows that there is a non-random connection between the absorbers and the galaxies in our data. If we assume that galaxies within the real group or cluster are distributed in velocity space according to a gaussian distribution, a one-to-one match between the absorbers and the galaxies cannot be established with the present data.

2 Conclusions

From these results we can conclude the following: (1) The detection of groups of Lyα absorption lines implies that some of the Lyα absorbers do actually cluster. (2) The velocity spanned by the Lyα absorption lines arising in groups or clusters is consistent with the velocity dispersion of the corresponding group or cluster of galaxies. This implies that the Lyα absorbers arising in those clusters occupy the same region in space than the galaxies themselves. (3) There is no strong preference for Lyα absorbers to avoid overdense environments. (4) Lyα absorption caused by galaxy groups or clusters arises in discrete clouds of cold gas, rather than in some hypothetical smoothly distributed cold phase in the intracluster medium.

References

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